

ACCELERATOR DIVISION DEPARTMENTAL PROCEDURE
AD/MECHANICAL SUPPORT

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Pelletron SF6 Gas Transfer Procedure

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1.0 Scope

This document describes the correct procedures for transferring SF₆ gas (sulfur hexafluoride) from the Pelletron to the storage tank, and from the storage tank to the Pelletron, using the NEC Model 1530M SF₆ Gas Transfer System (skid).

1.1 SF₆ Gas Transfer System Description

The NEC Model 1530M SF₆ Gas Transfer System (skid) is a manually operated full recovery gas system*. Its primary function is the transfer of Sulfur Hexafluoride (SF₆) gas between the Pelletron Tank and the Storage Tank.

1.1.1 NEC Model 1530M SF₆ Gas Transfer System Skid Components

The Kinney KT-300D vacuum pump is used to evacuate the Pelletron Tank before filling with SF₆. It is also used to evacuate the SF₆ Storage Tank before filling with SF₆ and in conjunction with the compressor to remove SF₆ from the Pelletron Tank below atmospheric pressure. The vacuum pump is interlocked with the cooling water flow switch mounted on the pump housing. A check valve (CV-1) that opens above atmospheric pressure protects the input to the vacuum pump. The output of the vacuum pump is protected by a 7 psig relief valve mounted on the Receiver Tank along with a pressure switch that turns off the pump when the output pressure is above 4 psig. Also, there is a 7 psig relief valve mounted on the Oil Separator Tank.



Figure 1 - Kinney KT-300D Vacuum Pump

* Templin, Robert E., "National Electrostatics Corporation Manual for Operation and Service of the Model 21A0066100 SF₆ Gas Transfer System," 1992.

The Blackmer Model HD-601-B compressor is used to transfer the SF6 between the Pelletron Tank and the Storage Tank. The compressor is interlocked with the cooling water flow switch mounted on the after cooler on the SF6 gas compressor output piping. A 125 psig pressure relief valve protects the SF6 gas compressor output. A 125 psig and 150-psig safety relief valve protect the Pelletron Tank and Storage Tank, respectively.



Figure 2 - Blackmer Model HD-601-B Compressor

Two filters are used on the system. One is located inside the SF6 Recirculation System mounted near the gas transfer system. The other filter is mounted on the gas transfer system. Whenever SF6 gas or air is put into the Pelletron vessel, it must pass through the filter on the gas transfer skid. When SF6 gas is transferred from the Pelletron tank into Storage, the dust filter on the gas transfer skid is not used. There is an important lockout feature found within this document. A double isolation (using valves V-1 and V-21 as per OSHA requirements) with a bleed to atmosphere (valve V-29) has been implemented to protect individuals entering the Pelletron vessel or the silo area beneath.

1.1.2 Thermo Scientific Neslab System 1

The Thermo Scientific Neslab System 1 is a water-to-water heat exchanger used to cool the Kinney KT-300D vacuum pump. Cool water is pumped from the Neslab through piping to a water inlet connection on the vacuum pump. Warm water leaves the vacuum pump through the water outlet connection and returns back to Neslab. The heat in the water from the vacuum pump is transferred to cold water from the AEC Chiller by the heat exchanger inside the Neslab.



Figure 3 - Neslab System 1 - Front



Figure 4 - Neslab System 1 - Back

The temperature of the water going to the vacuum pump is regulated by turning the adjustment knob on the face of the Neslab. When cooling is needed, cold water from the AEC Chiller is allowed to flow into the Neslab heat exchanger. Before operating the Neslab, make sure all four SF6 transfer skid chilled water supply and return isolation valves in the piping to the Neslab and to the compressed air aftercooler have been opened.

The flow of cold water from the AEC Chiller is started and stopped by a 2-way solenoid valve, inside the Neslab, located in the inlet piping from the AEC Chiller. This solenoid valve is very sensitive to the incoming pressure of the water from the AEC Chiller. If the valve closes and the incoming water pressure is too high, the valve may not reopen, causing the Neslab to overheat and shut itself down. If the solenoid valve seems to be stuck closed, close the valve on the inlet piping from the AEC Chiller to relieve the pressure. This should allow the solenoid valve to open.

The green light on the front of the Neslab only indicates that cooling is needed. The green light does not indicate that the solenoid valve is open, so do not rely on the light to indicate the status of the Solenoid valve.

A flow indicator has been installed in the chilled water return piping from the Neslab to the AEC Chiller. When the flow indicator shows no flow, either the isolation ball valves are closed, the solenoid valve has closed because cooling is not required, or the solenoid valve is stuck closed. If the solenoid valve is closed because no cooling is required, the green light on the front of the Neslab should be dark.

When the green light on the front of the Neslab is on, cooling is required, so the solenoid valve should open. If the flow indicator shows no flow, then the solenoid valve has become stuck in the closed position. Close the valve on the inlet piping from the AEC Chiller to relieve the pressure. This should allow the solenoid valve to open.



Figure 5 - Isolation Valves and Flow Indicator

1.2 Safety Requirements

Operators must become familiar with these procedures and system flow paths before operating the SF₆ gas transfer system. Read through the procedures that follow to become familiar with the steps involved. Familiarize yourself with the locations of the various switches, breakers, valves, and gauges before beginning the procedures described.

The Procedures must be followed in a step-by-step fashion to avoid problems during gas transfers, which could lead to a loss of SF₆ gas, contamination or damage to equipment. If at any time during a gas transfer procedure, a problem arises or the system needs to be shut down quickly.

First turn off the compressor and vacuum pump and immediately close valves V-18 and V-1 to isolate the Storage Tank and Pelletron Tank from the SF₆ gas transfer system. Then close all other valves on the system. An investigation and resolution of the problem must follow before resuming. All transitions must be entered in the SF₆ gas system logbook with corresponding date and time.



Figure 6 - NEC Model 1530M SF₆ Gas Transfer System Skid

2.0 Transfer of SF6 Gas from Pelletron Tank to Storage Tank

1. Each step must be followed in successive order unless otherwise noted.
2. Enter the time for each major transition in the e-log and paper logbook, also record the pressure and temperature for both the Pelletron (determine Pelletron tank pressure from ACNET address R:TNKPR which can be found on R117, mode= utilities, sub-page 2) and Storage tank from R:SF6STP.
3. Make a status entry in the E-Cool E-log. Record the initial pressures / temperatures of the tanks.
4. Close all numbered valves on the gas transfer skid.
5. Do not close valves to gauges. You will need to be able to read these gauges to complete the procedure, so make sure these valves are open.
6. Close valves BVS04S and BVT03S. Go to Recycler vacuum page R55, then click on Recycler Ring, and from the pop-up menu choose Electron Cooling, there you will find BVS04S and BVT03S. Close them. Or ask the control room to close them.
7. Check the vacuum pump sight glass and the compressor dip stick oil levels prior to starting them.
8. Ensure that large AEC water chiller system is on. The initial water chiller temp is around 34°F. Adjust the AEC water chiller temperature to 45°F using the up arrow on the chiller control panel.



Figure 7 - AEC Chiller Control Panel

9. **Contact Accelerator Division ES&H:** Call the AD-ES&H Department x3499 or LRP 630-612-8109. Ask them to be prepared to come out with the SF6 ppm meter, and the air-sampling device to check the air inside the Pelletron, and the “Confined Space” form. Give them a time estimate (8 hrs) of when they will be needed.
10. Open valve V-4.
11. If PI-2 is under a vacuum, open V-3 momentarily, and then close it.
12. Open all four SF6 transfer skid chilled water supply and return isolation valves in the piping to the Neslab and to the compressed air aftercooler, see Figure 5.
13. Turn on the Neslab power switch. Using the “Temperature Control” dial on the face of the Neslab, adjust the Neslab water out temperature to 18°C (65°F) to prevent a hard starting vacuum pump due to thick oil. While the Neslab is on, watch out for the solenoid valve sticking closed (see section ‘1.1.2 Thermo Scientific Neslab System 1’). If the Neslab will not turn on, check the water/glycol fluid level in the Neslab reservoir. If the water/glycol level is too low, the Neslab will not turn on. Fill the reservoir to the 'Fill Line' or approximately 10” up into the clear PVC piping at the top of the reservoir.
14. Energize the transfer skid and turn ON the vacuum pump (press and hold start button until pump starts). If the vacuum pump fails to start, make sure that cooling water is flowing to it.
15. Open the vacuum pump gas ballast valve shown in Figure 8 and pump for 20 minutes, this will help remove moisture from the vacuum pump oil and allow the pump to warm up.



Figure 8 - Vacuum Pump Gas Ballast Valve

16. Equalize the SF6 gas pressure between the Pelletron Tank and the Storage Tank by opening valves in this order; V-24 (on storage tank), V-23 (on catwalk), V-21, V-1, V-15, and V-13. Then, open valve V-11, and slowly open valve V-18 halfway.
17. After 10 minutes open valve V-18 three quarters open and wait another 5 minutes and open valve V-18 all the way.



Figure 9 - MCC Switch and Valve 18

18. When both tanks are at equal pressure (when R:SF6MAS and R:SF6STM are the same), close valve V-11.
 19. Open valves V-7, V-8, and V-9.
 20. Turn ON the SF6 gas compressor. Note: Stay as far away from the compressor as possible at start-up.
 21. When the SF6 gas compressor inlet pressure is 2 psig minimum to 4 psig maximum at PI-3, partially open valve V-12 to maintain PI-3 at 2 psig minimum. This allows the SF6 gas compressor to circulate without allowing the compressor inlet to drop into negative pressure.
 22. Close the vacuum pump gas ballast valve on the vacuum pump, (if open).
- NOTE:** Two people are required to perform the following steps. Operator #1 performs steps 23, 25 & 28 operator #2 performs steps 24, 27 & 29 **after** the Pelletron tank pressure reaches **less than 4 psig**.
23. (Operator #1) Partially open then close valve V-25 for about 3 seconds, until the pressure at gauge PI-2 reaches -25" Hg be sure V-25 is closed after 3 sec. This step will flush out the air remaining in the vacuum pump exhaust with a small amount of SF6.

24. (Operator #2) Open valve V-6 simultaneously with step 25.
25. (Operator #1) Simultaneously, close valve V-4 and open valve V-5.
26. At this point Operator #2 and Operator #1 should be standing in front of the transfer skid.
27. **Note:** Operator #1 should be ready to open V-25 as soon as V-13 & V-12 are closed. (Operator #2) Close valves in this order V-13, V-12 and V-15.
28. (Operator #1) **Immediately** partially open valve V-25 to maintain gauge PI-3 at 2 psig (minimum) to 4 psig (maximum) Monitor the vacuum pump at the power switch. TIP: If the vacuum pump trips wait a few seconds until gauge PI-3 indicates below 4 psig, then restart the vacuum pump, then close valve V-25 slightly less than the pre-trip position. Enter time and pressure values in logbook periodically during pump down.
29. (Operator #2) While Operator #1 is adjusting V-25 to maintain the compressor inlet at 2~4 psig. Operator #2 must perform configuration control lockout to the SF6 Recirculation System skid by closing valves V-43 and V-46 @ 1 psig. Then close V-44, V-45, when the Pelletron tank is at 0 psig or slightly less (the SF6 gas will remain in the dryer at 1 atmosphere, while the Pelletron is open.) Lockout the valves with configuration control padlocks.
30. Open KF25 valve V-65 and install an o-ring with a screen.
31. Lock open V-58 and V-64 (bleed valves) with configuration padlocks (located in the SF6 Recirculation System skid).
32. When PI-8 reads below zero psig, open capacitance manometer gauge isolation valve.
33. Open valve V-14. Doing so will remove a trapped pocket of SF6 behind V-14.
34. When valve V-25 is FULLY open, partially open valve V-2 while maintaining PI-3 gauge between 2 & 4 psig. Monitor the vacuum pump at the control box (green light) and watch for the vacuum pump to trip off. If it trips off, wait for the compressor to lower as shown on PI-3 below 4 psig, then re-start the vacuum pump.
35. When valve V-2 is FULLY open, close V-25 as pressure at PI-3 is beginning to decrease, partially open valve V-12 to maintain PI-3 at 2 psig (minimum) to 4 psig (maximum) at PI-3.
36. Continue pumping until the capacitance manometer gauge reaches < 0.050 Torr on gauge channel 1 (or < 50 mTorr on gauge channel 2).
37. After reaching < 0.050 Torr (or < 50 mTorr on gauge channel 2), close valve V-2. Valve V-1 should be open (note that PI-3 should be at least 2 psig, increase pressure by opening valve V-12 as needed after closing V-2).
38. Simultaneously open valve V-4 and close valves V-5. Close V-6.
39. Turn OFF the SF6 gas compressor. (Not the vacuum pump).
40. When the SF6 gas compressor **stops**, close valves V-18, V-7, V-8, V-9, and V-12.

41. Open valve V-16 to bleed air into the Pelletron Tank. Let the Pelletron tank reach atmospheric pressure.
42. Close valve V-23 (on catwalk) and V-24 (on storage tank) and lock them out with configuration control padlocks.
43. This is a good point to take a break, if necessary.
44. Reclaim the vacuum pump oil from the oil mist eliminator by opening valve "Oil return" on the vacuum pump. Close the "Oil Return" valve after the oil is recovered.
45. After the Pelletron tank reaches atmosphere, pump & purge the Pelletron tank TWICE by following steps 46 & 47.
46. Pump down to 50 Torr with the vacuum pump by closing V-16, then opening V-2 while maintaining -15" Hg at PI-2 exhausting through valve V-4.
47. Purge the Pelletron tank with air by closing V-2 and opening V-16.
48. Open recirculating gas ballast valve and wait 10 minutes.
49. Open valve V-3 for 30 seconds. With V-3 still open, turn OFF the vacuum pump and leave valve V-3 open for 30 seconds.
50. Turn off the Neslab power switch.



Figure 10 - Neslab

51. Close recirculating gas ballast valve.
52. Close valves V-3 and V-4.
53. When Pelletron Tank pressure is 0 psig (atmospheric pressure), close valves V-14 and V-16. Close and lock out valves V-1 and V-21 with configuration padlocks. Valve V 21 requires a special configuration padlock with a smaller shackle, PAD 126.
54. Open and lockout valve V-29 (bleed valve) with a configuration control padlock.
55. Notify Accelerator Division ES&H Section that the Pelletron tank will be ready for access in roughly 30 minutes. (Current ES&H contact is Richard Rebstock @ extension 3499 or Raymond Lewis @ extension 8445).
56. Secure SF6 gas handling skid by switching the MCC breaker OFF.
57. Adjust the AEC water chiller temperature up to 60°F (to prevent condensation from forming on cold piping while the Pelletron is open) using the up arrows on the chiller control panel.
58. Follow '**Pelletron Opening, Inspection Checklist and Closing Procedure ADDP-MS-000169, Section 2, Pelletron Tank Opening Procedure.**'
59. Enter final status entry in the E-Cool E-log. Record the final pressures / temperatures of the tanks.

Transfer is complete

3.0 Transfer of SF6 Gas from Storage Tank to Pelletron Tank

1. Each step must be followed in successive order unless otherwise noted.
2. Enter the time for each major transition in the logbook, also record the pressure and temperature for both the Pelletron (determine Pelletron tank pressure from ACNET address R:TNKPR which can be found on R117, mode= utilities, sub-page 2) and Storage tank from R:SF6STP.
3. Make a status entry in the E-Cool E-log. Record the initial pressures / temperatures of the tanks.
4. All numbered valves except V-29 on the gas transfer skid should be closed,
5. Do not close valves to gauges. You will need to be able to read these gauges to complete the procedure, so make sure these valves are open.
6. Close valves BVS04S and BVT03S. Go to Recycler vacuum page R55, then click on Recycler Ring, and from the pop-up menu choose Electron Cooling, there you will find BVS04S and BVT03S. Close them. Or ask the control room to close them.
7. Check the vacuum pump sight glass and the compressor dip stick oil levels prior to starting them.
8. Ensure that large AEC water chiller system is on. The initial water chiller temp is should be around 60°F while the Pelletron is open. Adjust the AEC water chiller temperature to 45°F using the down arrow on the chiller control panel.



Figure 11 - AEC Chiller Control Panel

9. Ensure that the Pelletron Tank is secured per ADDP-MS-000169 (Pelletron Opening, Inspection Checklist and Closing Procedure) and the Power Supply Test Checklist has been completed. Also, ensure that grounding rod assembly is secured closed.
10. To start the procedure, all the air must first be removed from the Pelletron tank before backfilling with SF₆.
11. If PI-2 is under a vacuum, open V-3 momentarily, and then close it.
12. Open valve V-4.
13. Make sure all four SF₆ transfer skid chilled water supply and return isolation valves in the piping to the Neslab and to the compressed air aftercooler are open.
14. Turn on the Neslab power switch. Using the "Temperature Control" dial on the face of the Neslab, adjust the Neslab water out temperature to 18°C (65°F). While the Neslab is on, watch out for the solenoid valve sticking closed (see section '1.1.2 Thermo Scientific Neslab System 1').
15. Energize the transfer skid and turn ON the vacuum pump (press and hold start button until pump starts). If the vacuum pump fails to start, make sure that cooling water is flowing to it.
16. Open the vacuum pump gas ballast valve shown in Figure 12 and pump for 20 minutes, this will help remove moisture from the vacuum pump oil and allow the pump to warm up.



Figure 12 - Vacuum Pump Gas Ballast Valve

17. Close the recirculating gas ballast valve (shown in Figure 12).
18. Open the capacitance manometer gauge valve; make sure it is on channel 1, as the pressure drops below 10 Torr switch to channel 2.
19. Open valve V-14.
20. Check vacuum pump ultimate pressure by opening valve V-2. Record ultimate pressure value and vacuum pump temperature in logbook.
21. Close valves V-58 and V-64 (bleed valves) apply configuration padlocks locking them closed. Close V-65 (the KF25 valve, located in the SF6 recovery/vacuum evacuation pipe).
22. Remove configuration locks from valves V-44, V-45, and V-21 and open them. Opening V-44 & V-45 prevents SF6 contamination with a trapped volume of air.
23. Remove configuration locks from V-1 and V-29 then close V-29 (bleed valve) and reapply a configuration lock to valve V-29. Also, post the ODH sign at the Pelletron entrance.
24. Throttle valve V-1 open, while maintaining -15" Hg at PI-2. You are now evacuating air in the Pelletron Tank, with the vacuum pump, with discharge to atmosphere.
25. After roughly 5 minutes, open valve V-1 all the way. If the capacitance manometer gauges don't reach 10 Torr after 1-1/2 hours, investigate for possible leaks. Periodically reclaim the vacuum pump oil from the oil mist eliminator by opening valve "Oil return" on the vacuum pump. Close the "Oil Return" valve afterwards.
26. As the pressure in the Pelletron drops below 10 Torr, switch the capacitance manometer controller to channel 2. Continue pumping until capacitance manometer reaches at least 175 mTorr (duration roughly 2 hours). Enter time and pressure values in logbook periodically during pump down.
27. Remove configuration padlocks and open valves V-23 and V-24.
28. Close valve V-2.
29. Close the capacitance manometer gauge valve.
30. Match the SF6 gas pressure in the Pelletron with the SF6 Recirculation System skid pressure shown on PI-73 (on blower skid), by opening valves V-13 and V-11, and slowly opening valve V-18 half-way. This allows the SF6 gas to flow from the storage tank into the Pelletron so when valves V-43 and V-46 are opened in the next step, the pressures between the Pelletron and the SF6 Recirculation System skid are nearly equal. Monitor the pressure of the Pelletron, via the ACNET address: R:TNKPR, (can be found here: ACNET page R117, Utilities, sub page 2) and the pressure of the recirculation skid, at gauge PI-73. Stop when the recirculation skid and Pelletron tanks are equal by closing V-18. Go to the next step.

31. Remove the configuration padlocks from valves V-43 and V-46 on the recirculation skid. When the pressure of the SF₆ gas in the Pelletron tank is equal to the recirculation skid (close to atmosphere), close valve V-18 to temporarily stop the equalization, then slowly open valve V-46, then open V-43.
32. Continue equalizing SF₆ gas pressure between the Storage Tank and the Pelletron Tank by opening valve V-18 half-way. When the Storage Tank and Pelletron Tank are within 20 psig of equalizing, open valve V-18 all the way.
33. Check for SF₆ leaks with the SF₆ detector, as the gas is transferring, concentrate on all flanges that were open during the access.
34. Open valve V-3 for 30 seconds.
35. Turn OFF the vacuum pump and leave valve V-3 open for 30 seconds.
36. Turn off the Neslab power switch.



Figure 13 – Neslab

37. Close valves V-3 and V-4.
38. Continue equalizing the storage and Pelletron tanks until equalized. (When R:SF6MAS & R:SF6STM are close to the same, there may be a slight difference).
39. Close valve V-13.
40. Open valves V-7, V-8 and V-10.
41. Turn ON the SF6 gas compressor.
42. Continue compressing SF6 gas until the Pelletron Tank reaches a pressure of 72 psig shown on PI-8 or via the ACNET address: R:TNKPR, (can be found here: ACNET address R:TNKPR which can be found on R117, mode=utilities, sub-page 2). Do NOT allow the SF6 gas compressor inlet pressure to drop below 0.5 psig on R:SF6STP.
43. Turn OFF the SF6 gas compressor.
44. When the SF6 gas compressor **stops**, close valves V-8 and V-7. (This leaves a slight positive pressure in the lines between the Storage Tank and the SF6 Gas Transfer Skid).
45. Close valves V-18, V-24, V-23, V-11, V-10, V-14, V-1 and V-21.
46. Check for SF6 leaks with the SF6 detector, concentrate on all flanges that were open during the access.
47. Secure SF6 gas transfer skid by switching off the MCC breaker. Turn off the Neslab power switch.
48. Adjust the AEC water chiller temperature back to 34°F using the down arrows on the chiller control panel.
49. Enter final status entry in the E-Cool E-log. Record the final pressures / temperatures of the tanks.
50. Close all four SF6 transfer skid chilled water supply and return isolation valves.

Transfer is complete